

Nanophase Carbonates on Mars: Does Evolved Gas Analysis of Nanophase Carbonates Reveal a Large Organic Carbon Budget in Near-surface Martian Materials?

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Evolved Gas Analysis (EGA), which involves heating a sample and monitoring the gases released, has been performed on Mars by the Viking gas chromatography/mass spectrometry instruments, the Thermal and Evolved Gas Analyzer (TEGA) on the Phoenix lander, and the Sample Analysis at Mars (SAM) instrument on the Mars Science Laboratory. All of these instruments detected CO₂ released during sample analysis at abundances of ~0.1 to 5 wt% assuming a carbonate source. The source of the CO₂ can be constrained by evaluating the temperature of the gas release, a capability of both the TEGA and SAM instruments. The samples analyzed by SAM show that the majority of the CO₂ is released below 400 °C, much lower than traditional carbonate decomposition temperatures which can be as low as 400 °C for some siderites, with magnesites and calcites decomposing at even higher temperatures.

In addition to mineralogy, decomposition temperature can depend on particle size (among other factors). If carbonates formed on Mars under low temperature and relative humidity conditions, the resulting small particle size (nanophase) carbonates could have low decomposition temperatures. We have found that calcite can be synthesized by exposing CaO to water vapor and CO₂ and that the resulting mineral has an EGA peak of ~550 °C for CO₂, which is about 200 °C lower than for other calcites. Work is ongoing to produce Fe and Mg-bearing carbonates using the same process.

Current results suggest that nanophase calcium carbonates cannot explain the CO₂ released from martian samples. If the decomposition temperatures of Mg and Fe-bearing nanophase carbonates are not significantly lower than 400 °C, other candidate sources include oxalates and carboxylated organic molecules. If present, the abundance of organic carbon in these samples could be > 0.1 wt % (1000s of ppm), a significant departure from the paradigm of the organic-poor Mars based on Viking results.